COCOA Simulation and Study of the EMU Alignment System

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CMS EMU Alignment Update

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Simulation Status

Description of EMU Alignment System Geometry and Components Complete

Includes

- CSC Chamber Definition

  < 10 μm Agreement on ME ±1 w/ Production Drawings

  < 5 μm Agreement on ME ±2, ±3, ±4 w/ Prod. Drawings
- Transfer Plates
- Secondary Sensors: Inclinometers, Proximity Sensors

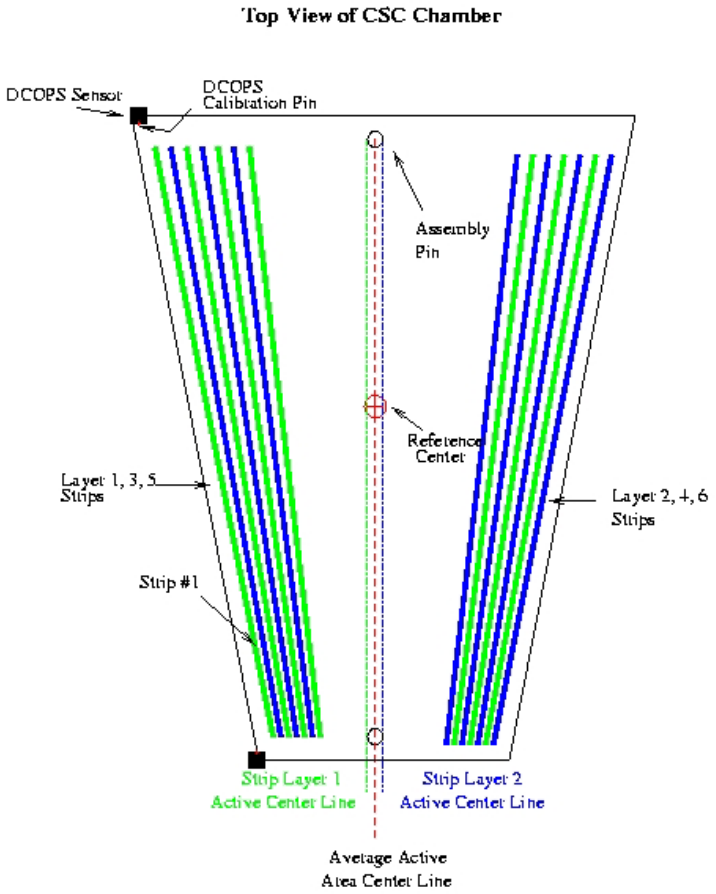
Realistic Estimation of Uncertainties on CSC Construction and Strip Placement

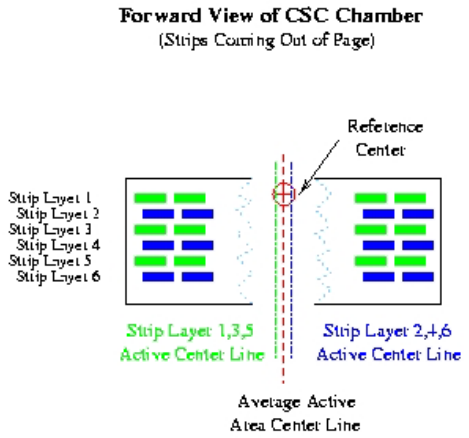
First Estimation of System Uncertainties

CSC Definition in COCOA

CSC Definition:

2 DCOPS Placed Relative to the 'Reference Center' of the Chamber





Note : A perfectly constructed CSC has the Geometric Center Line and Average Active Area Center Line overlapping.

Uncertainty in DCOPS - Reference Center Relationship*

CSC X-Axis (Perpendicular to Centerline, ~CMS RΦ) :

Uncertainty Origin	Magnitude (μm)
Central Alignment Pin - Notched Alignment Marks	25
Notched Alignment Mark - Numbered Reference Strip	25
Intrinsic Strip Positioning (from milling)	30
Averaged Centerline Across 6 Assembled Planes	87
Positioning of Primary DCOPS Alignment Pins/Holes	25
Diameter of Primary DCOPS Alignment Pins/Holes	25
Placement of Mounting Plate On Chamber	50
Placement of DCOPS Mounting Plate	50
DCOPS Calibration, Construction**	65
Maximal Shearing Effect (Averaged across 6 layers, No Reliable Data)	25

Final Estimation of Uncertainty Along X Axis of Chamber: 144 μm

* **Estimates based on data supplied by O. Prokofiev, N. Chester, Muon TDR, CMS Internal Notes**

** **Estimate based on 40 μm 1st Pixel Calibration + *COPS Sensor Board Calibration, J. Moromisato et al, Oct 2000***

Uncertainty in DCOPS - Reference Center Relationship*

CSC Y-Axis (CMS Z) :

Uncertainty Origin	Magnitude (µm)
Panel Thickness (Maximal deviation)	508
Frame to Panel Placement	127
Mounting Bracket Chamber-Shim Standoff	100
Mounting Bracket Al. Plate	125
DCOPS Calibration, Construction**	65

Final Estimation of Uncertainty Along Y Axis of Chamber: 551 µm

Uncertainties which are asymmetric are estimated as symmetric at max deviation

Examples: Panel Thickness Uncertainty is +508 µm - 245 µm
Mounting Bracket Chamber-Shim Standoff +100 µm - 0 µm
Average Sheering Effect between layers is asymmetric

* Estimates based on data supplied by O. Prokofiev, N. Chester, Muon TDR, CMS Internal Notes

** Estimate based on 40 µm 1st Pixel Calibration + *COPS Sensor Board Calibration, J. Moromisato et al, Oct 2000*

Other Uncertainties in the COCOA EMU Simulation

Hardware (Transfer Plates, Z Standoffs, etc)

- Estimates from production drawings

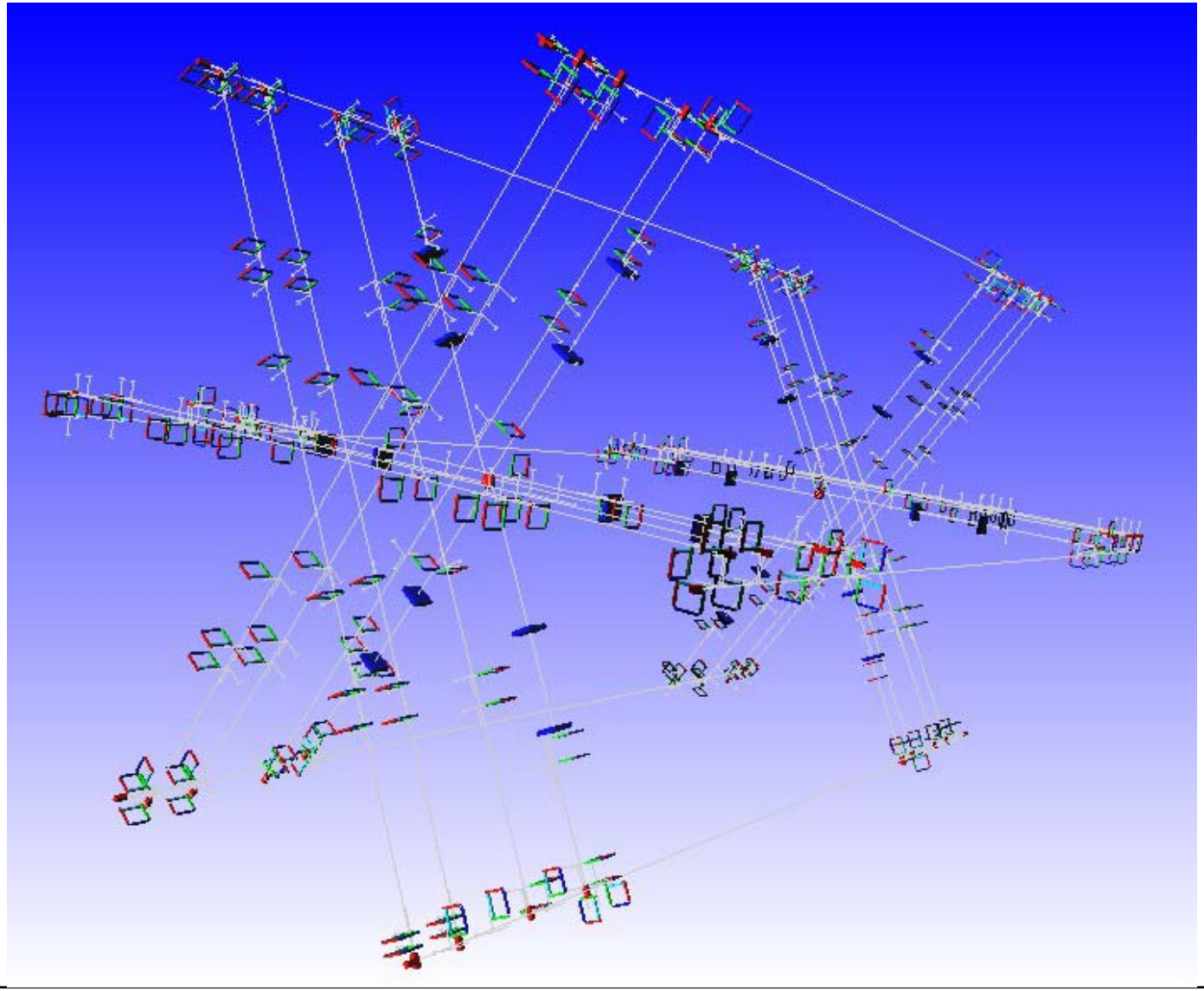
MAB Uncertainty

- ±135μm ±30 μrad on MAB Placement
- ±50μm ±10 μrad on DCOPS Placement on MAB

Measurement Uncertainties

- Performance of all devices set to long term, uncorrected resolutions found in 2000 ISR tests
- Secondary LINK Laser Line Uncertainty set to ±20μm and ±10 μrad
- Link 2D Sensor Modeled as making 5um measurements

COCOA Model of EMU Simulation



Full EMU COCOA Simulation

Full EMU Simulation Model has :

- > 19000 Lines Text in Input File
- > 6200 Entries to Fit
- > 6000x1500 Matrix Constructed for Fit

THIS IS A PROBLEM !!!

- Computer(s) Crash with error indicating problem is with memory (allocation + usage)
- 1 iteration of ME ±2, ±3, ±4, and Transfer System with completed on System with > 1 GB RAM (with 92% memory used before I killed it)
- Temporary Solution is to Compare Subsets of Full System, look for correlations

Comparison of Subset Simulations

- All Sub-Systems Had Full Transfer Line
- Largest Sub-System has 6 ME Disks
  - ME ±2, ±3, ±4 w/ Transfer System
- All Permutations of 2 ME Disks + Transfer System were examined (56 Separate Simulations)

Conclusion :

Estimates of equal size systems are comparable

Estimates from smaller systems are comparable to estimates from larger systems

1st Simulation Study Results

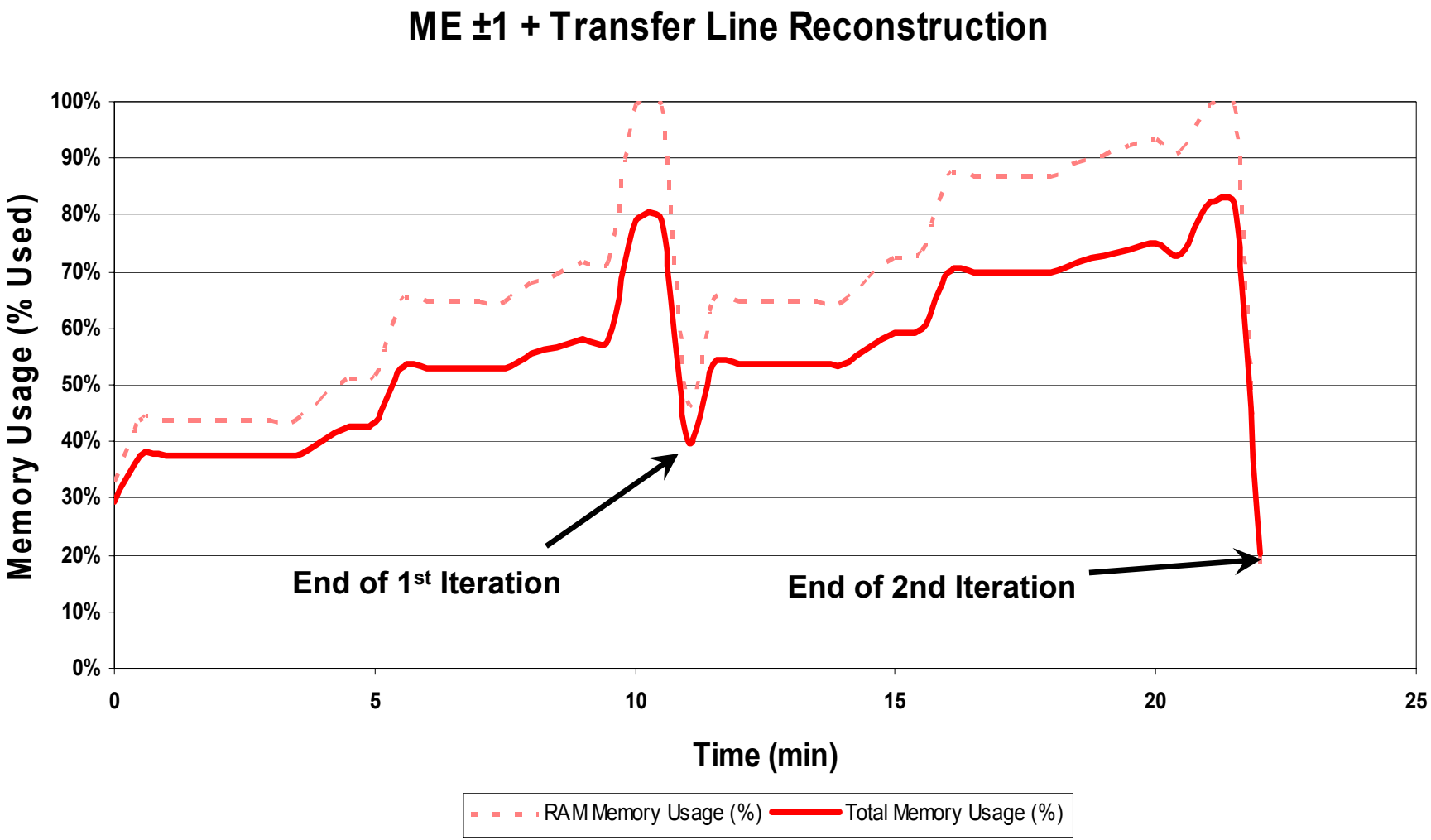
Uncertainty in Reconstruction of CSC Reference Center*

	σ CMS RΦ (μm)	σ CMS Z (μm)
ME ±1/2 (σ inclinometer = short term ISR)	160 – 175 (90 95)	370 – 420 (370 385)
ME ±1/3	210 – 225	670 – 880
ME ±2/1, ±3/1, ±4/1	190 – 210	400 – 420
ME ±2/2, ±3/2, ±4/2	220 – 250	400 – 450

* Translation to any strip position in chamber at wide end is ~40μm in quadrature with above σ

COCOA Memory Usage

Pentium II 400MHz with 392MB RAM



Final Remarks on COCOA

- Memory Problem is serious for large systems
- Additional Debugging and Optimization is Required
- Reconstruction should by done piece by piece
- More Documentation & Numerous Sample Scripts for New Users